

Spatio-temporal responses to climate across trophic levels: Macroscopic observations of plant phenology and animal movement in the Western United States

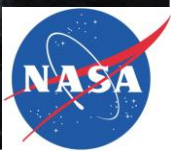
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Guiding Question

How do spatial and temporal variations in primary productivity transmit to higher trophic levels?

- Abundance
- Mortality
- Home range
- Movement

ovement Over Dail

Location (GPS)

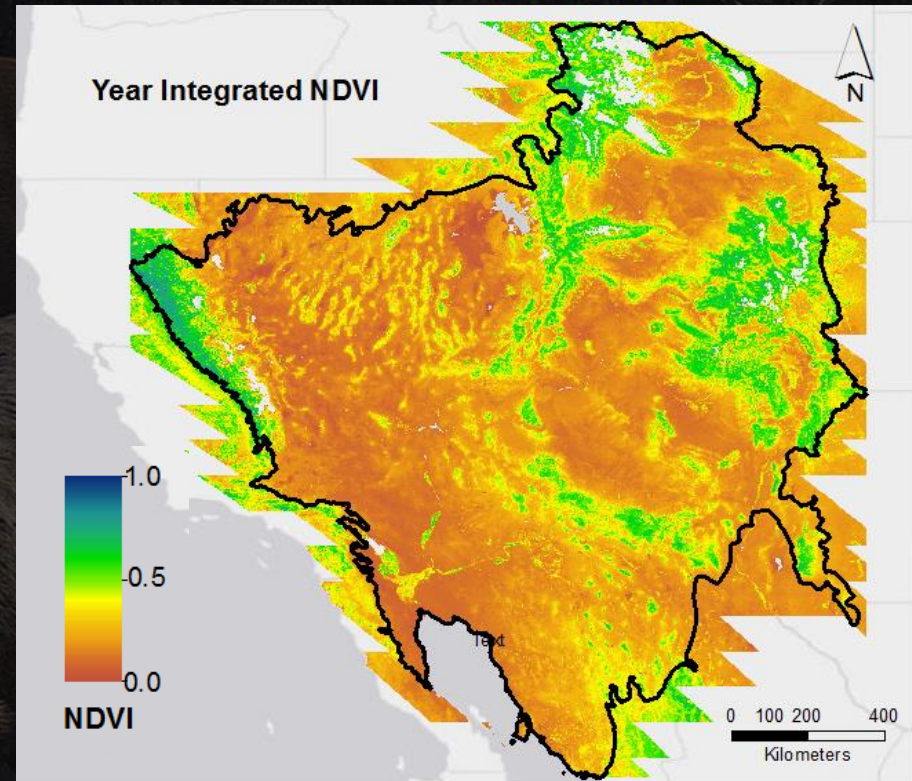
- Cougar: 91
 - Mule deer: 127
 - Bighorn sheep: 82
 - Elk: 30
- (and one bobcat)*

Productivity (NDVI)

- Daily MODIS NDVI (2000-2012)
 - Quality-screened
 - Cloud-masked and BRDF-corrected
 - Time-interpolated
- Long-term norms and summed anomalies

Study area phenology: *primary productivity in space and time*

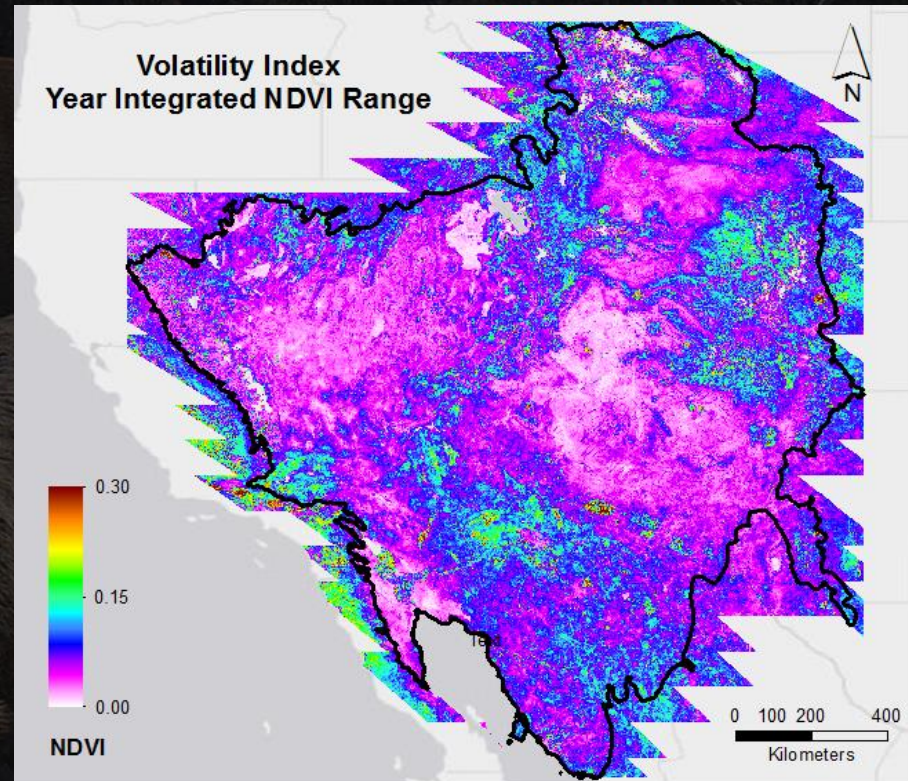
- Precipitation-limited
- Topographically structured
 - High-elevation forests
 - Low-elevation deserts



13-year norm of mean annual NDVI (daily, 250-m resolution).

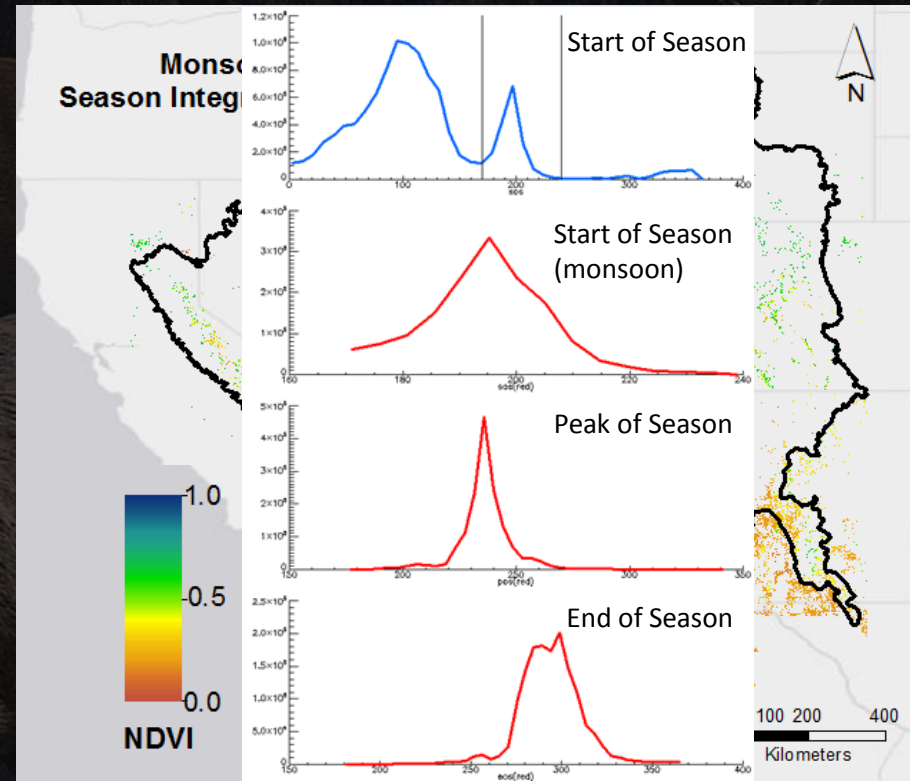
Study area phenology: *primary productivity in space and time*

- Precipitation-limited
- Topographically structured
 - High-elevation forests
 - Low-elevation deserts
- Stable (low) desert productivity
 - Great Basin
 - Colorado Plateau
 - Mojave
 - Chihuahua
- High variation in montane/alpine
 - duration of snowpack
- High variation in Sonoran Desert
 - North American Monsoon



13-year 2 SD of mean annual NDVI (daily, 250-m resolution).

Study area phenology: *primary productivity in space and time*



13-year norm of mean annual NDVI (daily, 250-m resolution).

- Duration: DOY 170-220
- Peak: DOY 236 (Aug 24)

Home-range productivity vs. area

How far must a consumer roam?

Home-range Comparison Between NDVI Extremes

Southern Nevada

Area: 759.56 Km²
NDVI: 0.23899 ± 0.0311



0 5 10 20 Kilometers

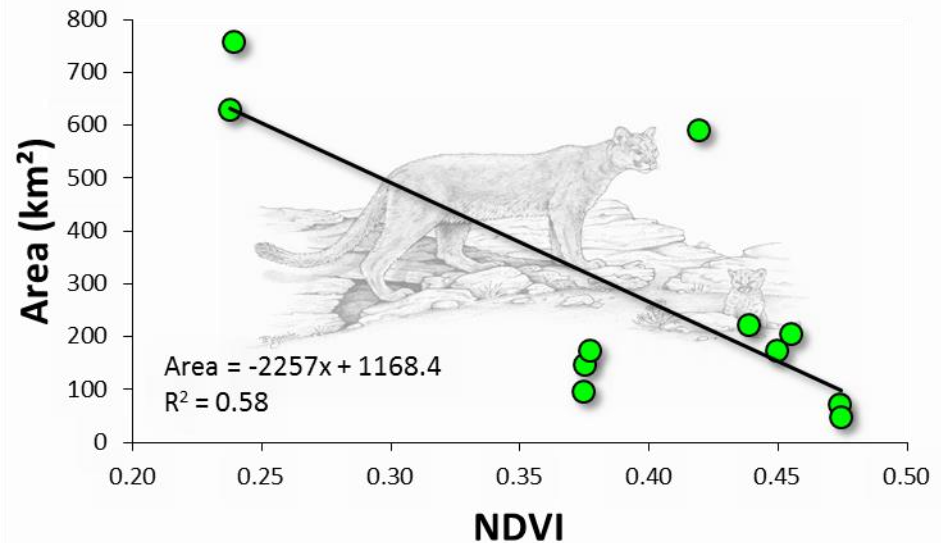


Oquirrh Mountains, Utah

Area: 71.66 Km²
NDVI: 0.47389 ± 0.0848

0 5 10 20 Kilometers

scale: 1:300,000



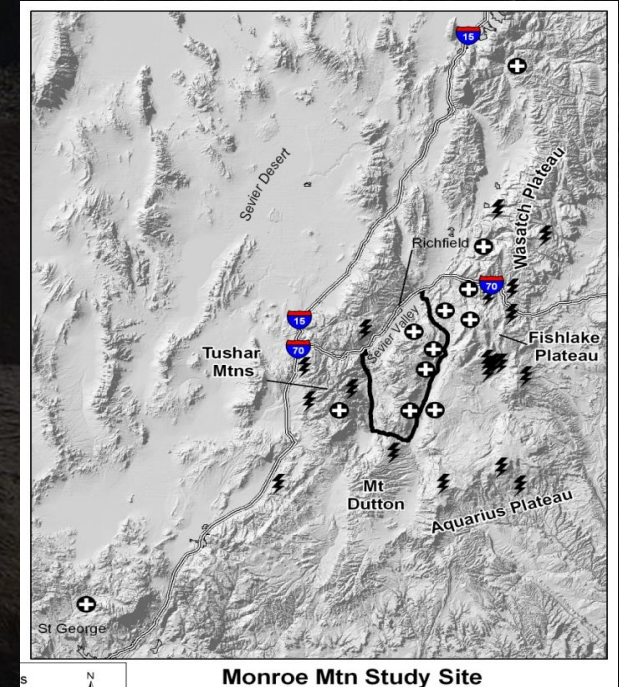
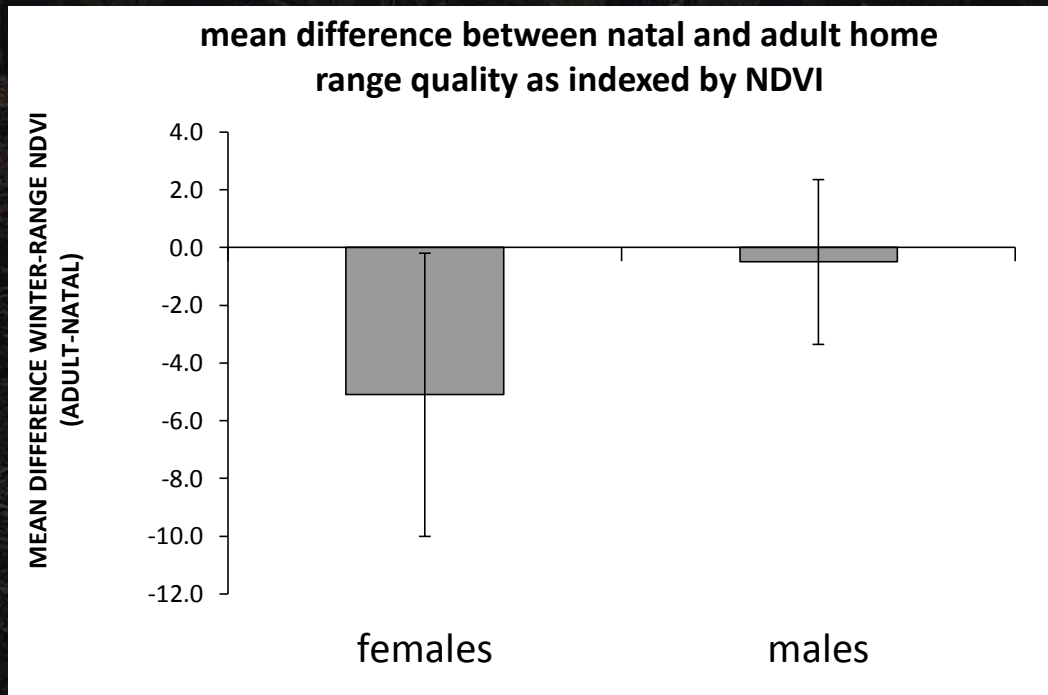
Productivity-area relationship of female *F. concolor* home-range

Study Areas (n): Oquirrh (2), Monroe (1), Stansbury (3), Capitol Reef (1),
Grand Canyon (1), Nevada (2), Zion (1)

With the widest latitudinal range of any large terrestrial animal, the cougar is an ideal species to quantify this long-standing biogeographic generalization.

Primary productivity and cougar dispersal:

Do offspring select better or worse habitat than their natal range?



- Insignificant difference between male origin and destination.
- *Young females settle in less productive habitat than males.*

Hunting mortality in *P. concolor*:

Habitat productivity vs. exposure to humans

At continental scale, the range of cougars has contracted to the lowest-productivity, most remote portion of their historic range.

- Habitat quality and remoteness interact to determine hunting mortality.
- Ecological traps: Cougars in high-productivity habitat near humans suffer greatest hunting mortality.
 - High-quality sinks
- De facto refugia: Cougars in remote, unproductive habitat experience lowest hunting mortality.
 - Low-quality sources

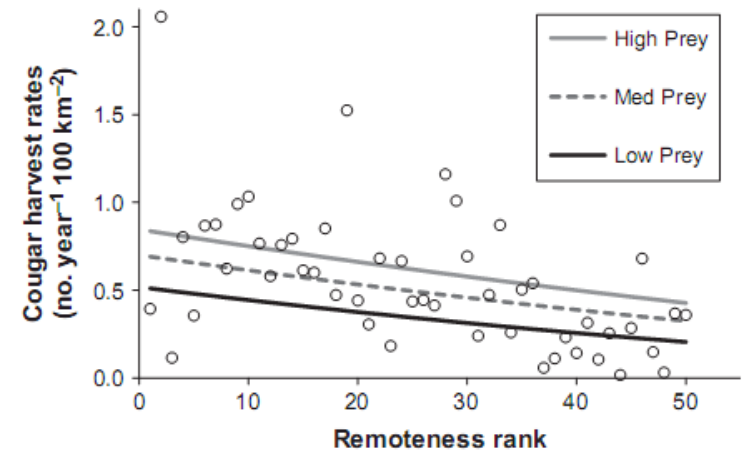
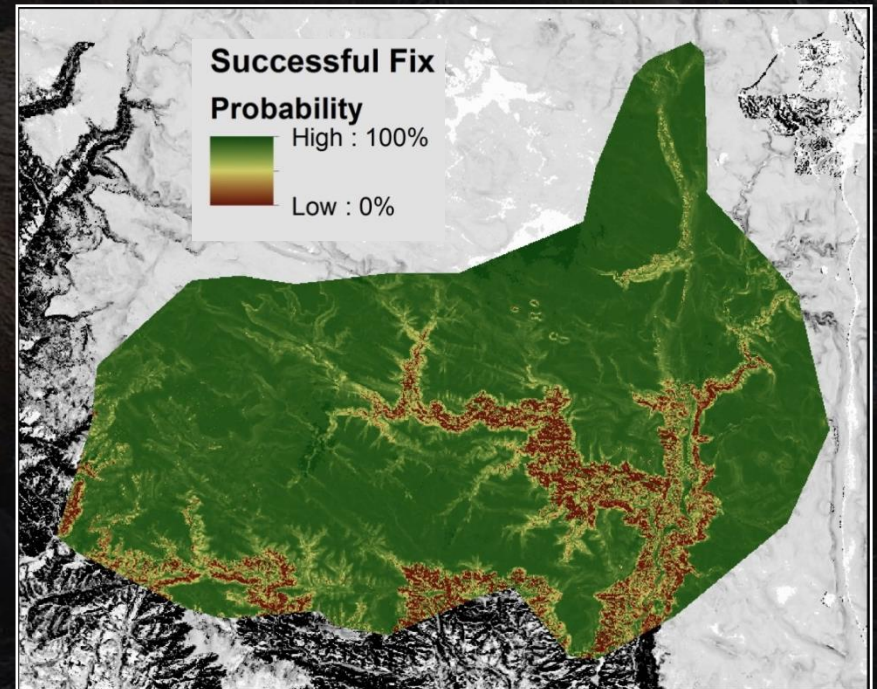
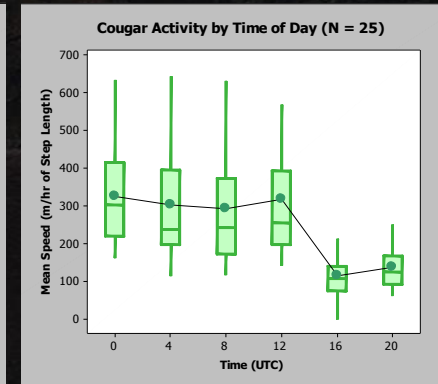
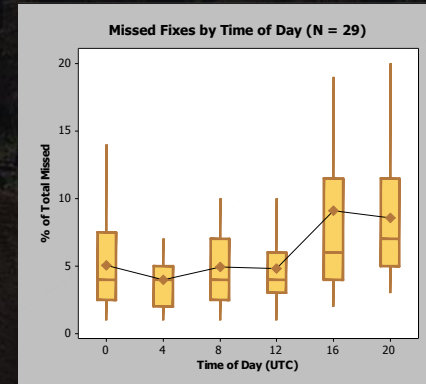


Figure 2 The effect of remoteness on the distribution of cougar harvest (controlling for variation in prey density). Regressions are presented as median values for high, medium, and low prey densities.

Anthropogenic > climatological factors in determining range contractions.

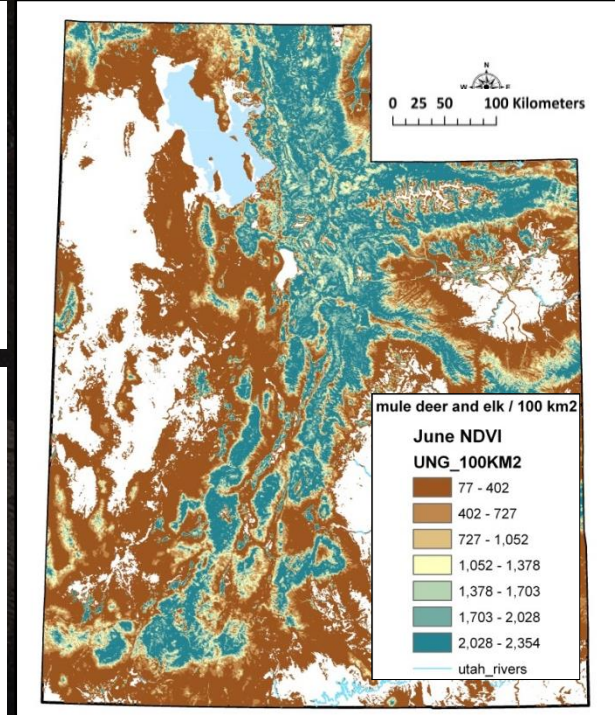
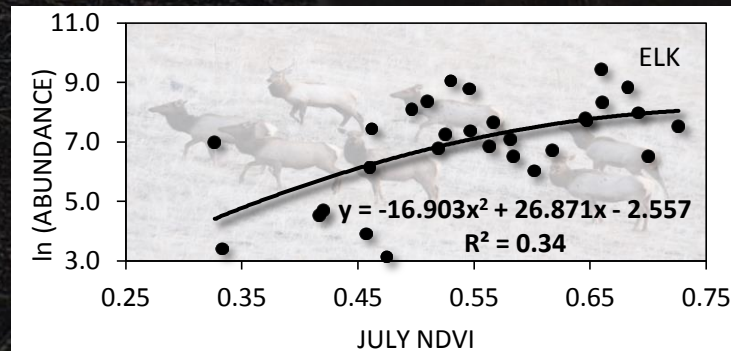
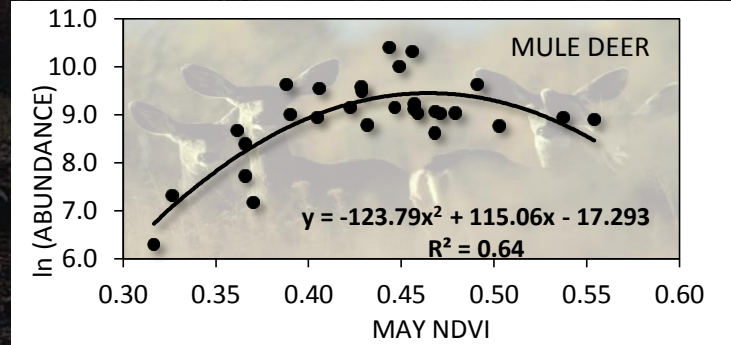
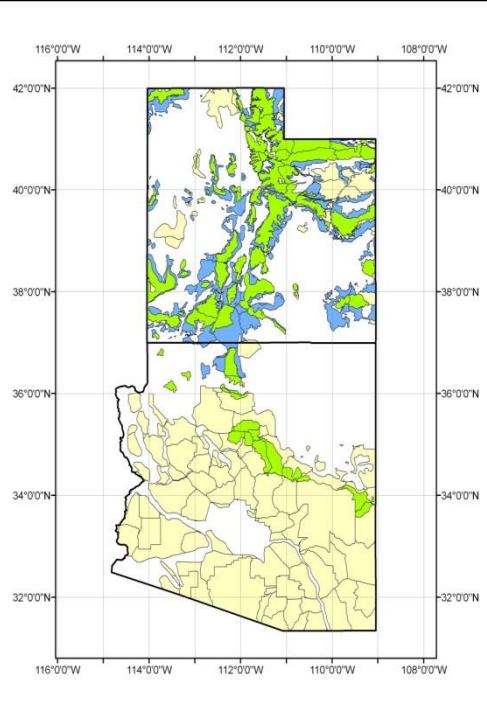
Technical, behavioral, and environmental constraints on GPS signal reception

- Sampling bias
 - Caused by several factors
 - Transmits to all subsequent analyses
 - Can be modeled and removed
- Terrain is strongest environmental constraint on acquisition
 - Canopy-cover and -height effects significant also
- Brand effect small, but significant
 - Telonics better than Lotek
- Loss rate doubled during the day
 - Cougars rest under cover during daylight



Primary productivity and herbivore abundance

Toward a dynamic regional habitat map



Growing-season productivity (NDVI) is a strong, but nonlinear correlate of ungulate abundance.

- Deer (specialist) more sensitive to spring greenup.
- Elk (generalist) more sensitive to peak summer productivity.

Now hiring

- M.S. Assistantship (B.S.-level)
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- Tom Edwards, t.edwards@usu.edu



Questions?

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